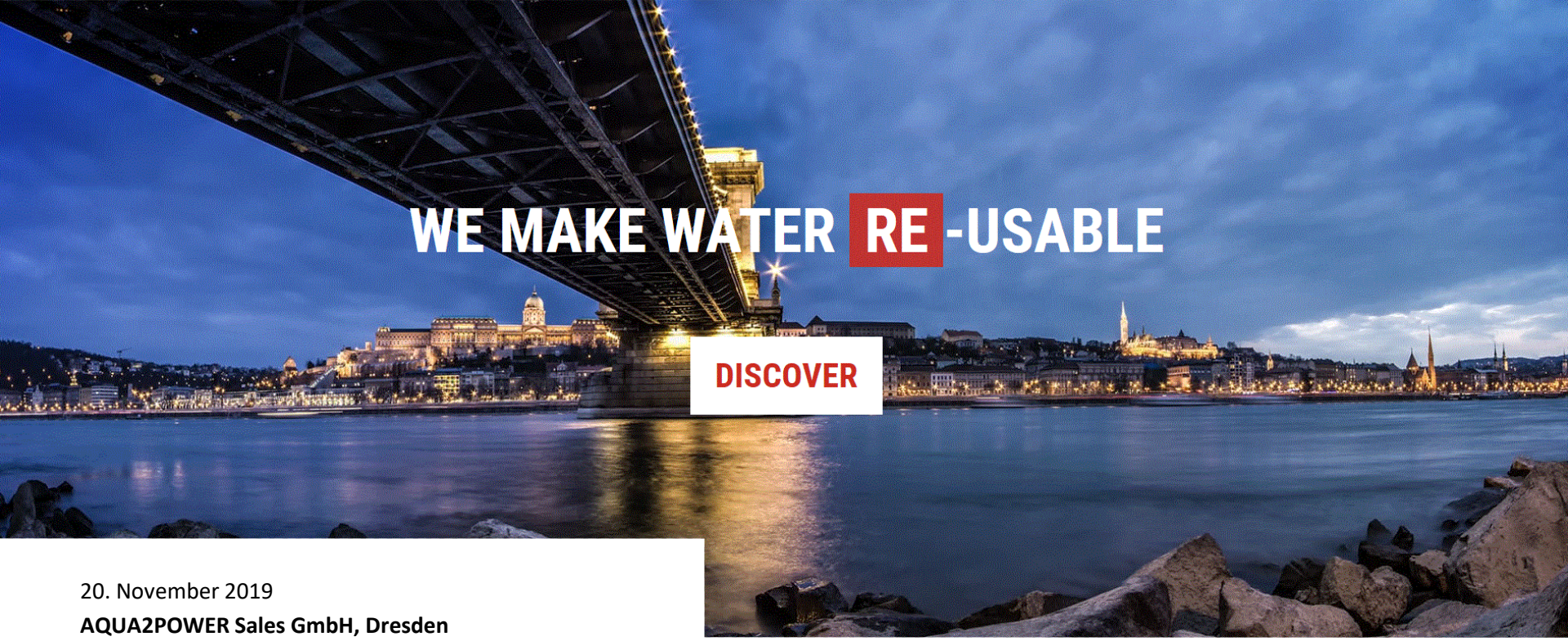
11-17-2019

Energy Sheet Pilings - A milestone for emission free, renewable power production

Bernd Vogl
Aqua2Power AG, Germany



20. November 2019

AQUA2POWER Sales GmbH, Dresden

ENERGY SHEET PILE SYSTEMS

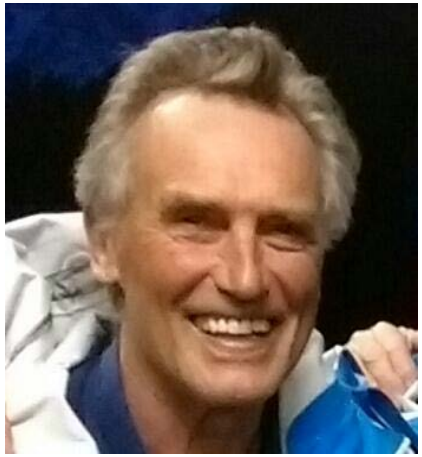
A MILESTONE FOR EMISSION FREE, RENEWABLE POWER PRODUCTION

AQUA POWER

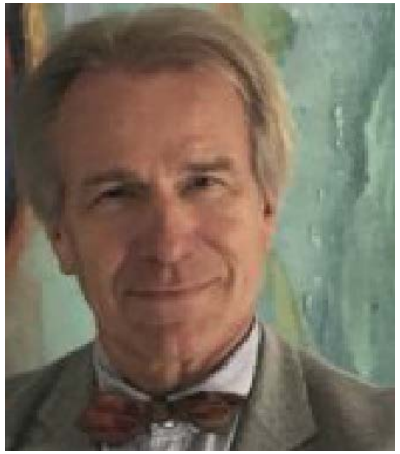
MISSION STATEMENT FROM GERMANY

Dr.-Ing.
Bernd Vogl
Technical Building Equipment

Dr. rer. nat.
Thomas Noll
Research & IP



Dipl.-Phys.
Bernhard Puttke
Research & IP



Prof. Dr.-Ing.
Herbert Klapperich
Geo-Technology

AQUA POWER

Energy Sheet Pilings can **very effectively** be applied for **heat dissipation in warmer regions**, like for example for the **cooling of buildings**.

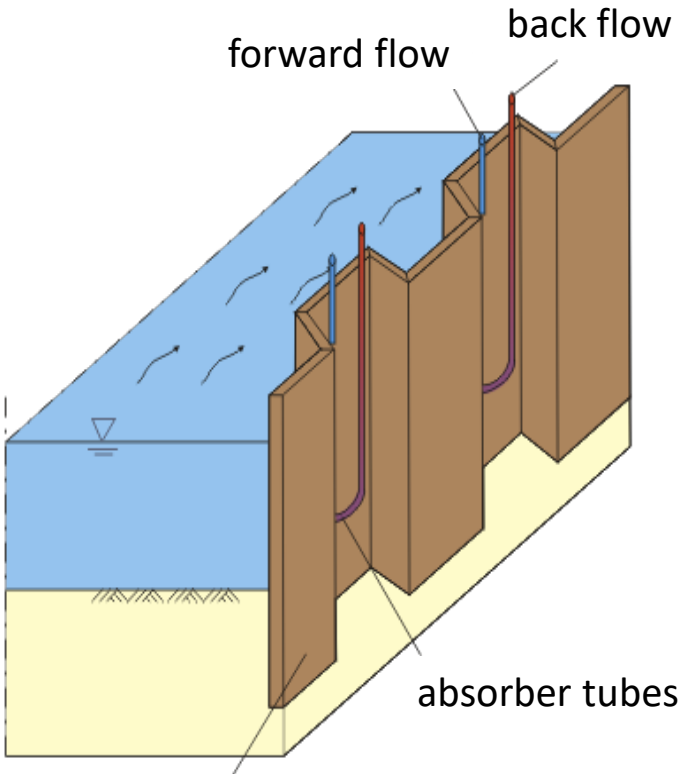
The **implementation** can be undertaken **at open waters** and **at ground water embedded buildings**, whereas the sheet piles remain in the ground.

CONTENT

- **What is an Energy Sheet Pile?**
- Research – what do we expect?
- First Applications
- The Energy Harbour with Energy Sheet Pile Systems
- Vision Next – The Hybrid Hydro Power Plant

WHAT IS AN ENERGY SHEET PILE?

FUNCTION OF AN ENERGY SHEET PILE

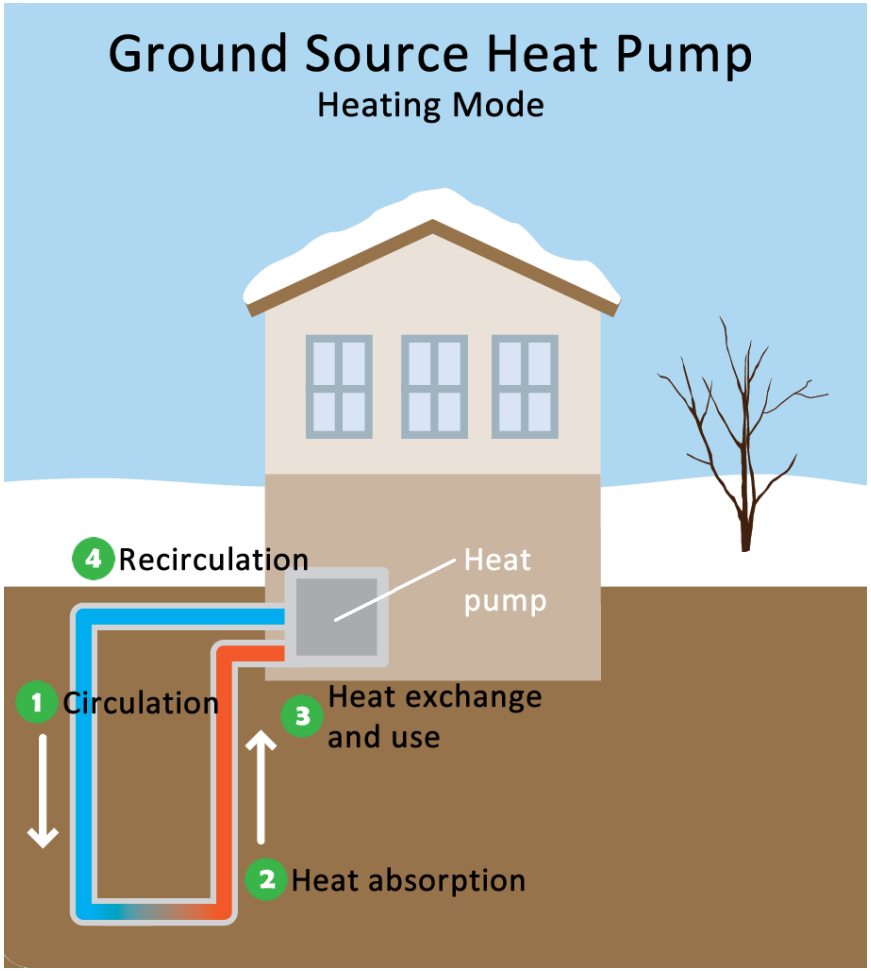


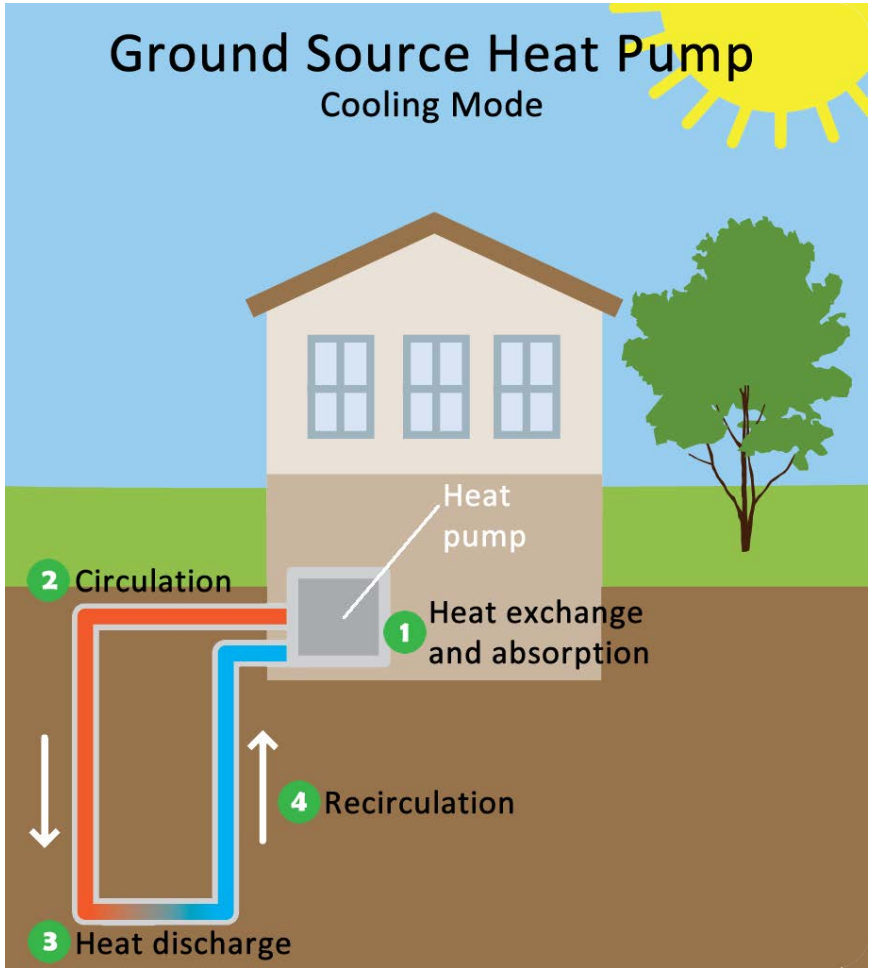
Energy Sheet Pile

Picture: Koppmann, RWTH Aachen, Germany

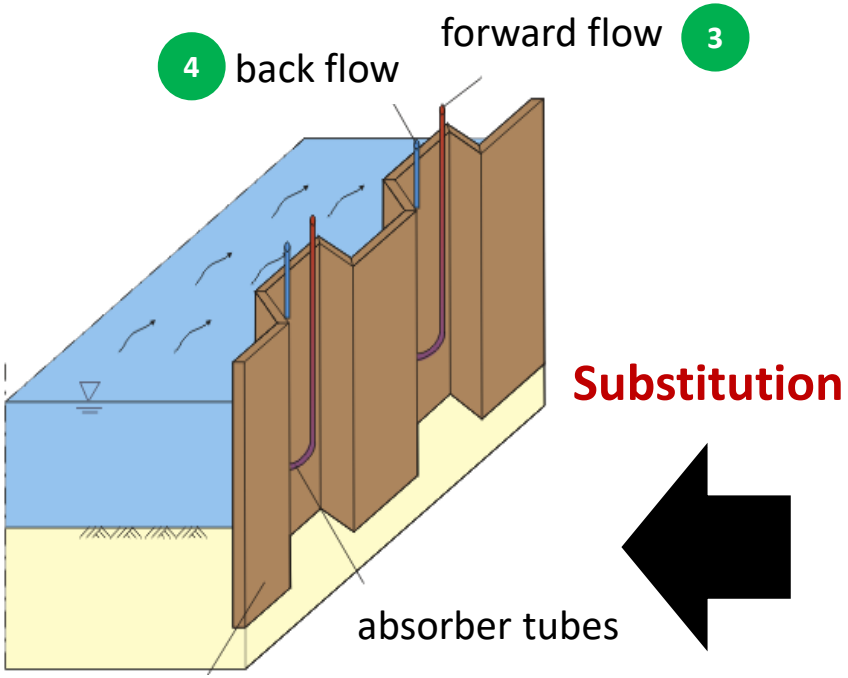
- An energy sheet pile is a **geothermal heat exchanger**, which is operated as a heat source **with a heat pump**.
- The source circuit is closed, a **heat transfer medium** is used.
- In addition, the energy sheet pile can also be used for **passive or active cooling**.
- The energy sheet pile is then used as a real **alternative for earth collector or groundwater heat pumps** when the soil leads to very high energy flows **due to high humidity** (groundwater flow) or **directly in or on the water** (lake, river).

STATE OF THE ART: HEATING & COOLING WITH GROUND SOURCE HEAT PUMPS





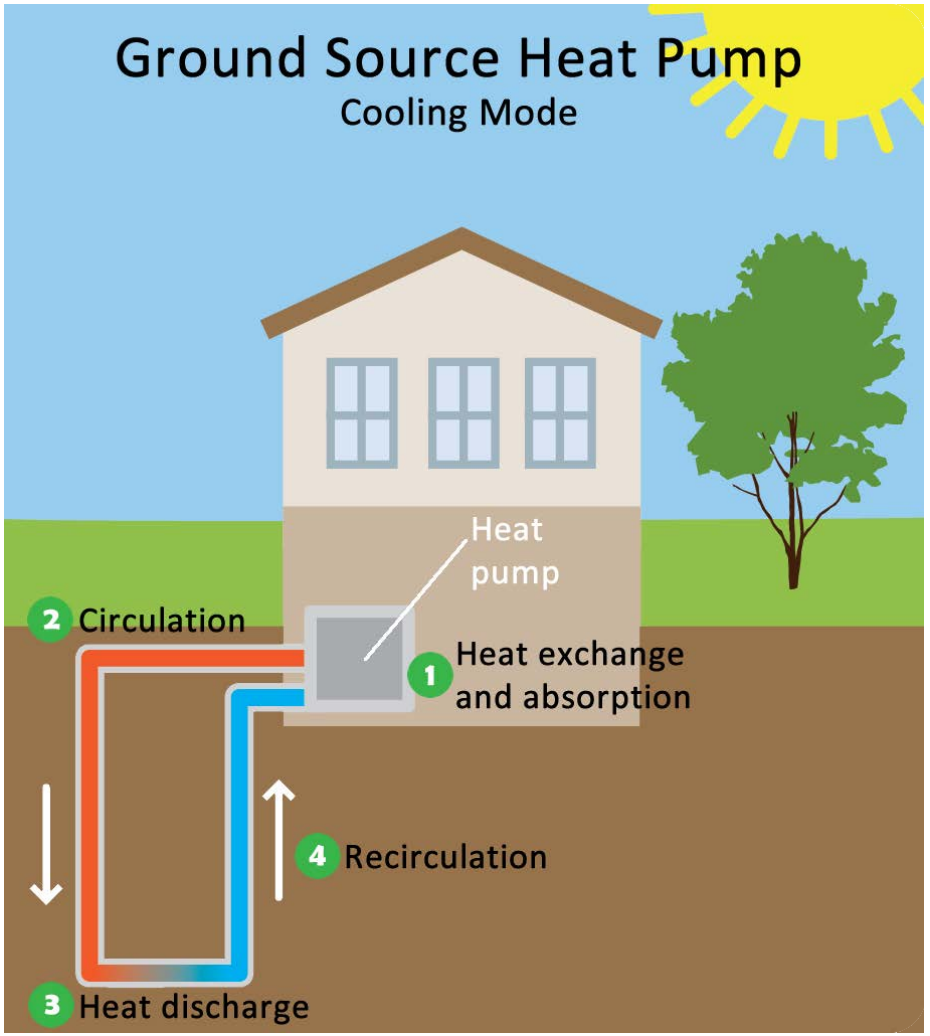
NEW APPROACH – SUBSTITUTING THE SOURCE FOR HIGHER SYSTEM EFFICIENCY



Energy Sheet Pile

Picture: Koppmann, RWTH Aachen, Germany

Substitution



IDEAL AREAS OF APPLICATION AND SUITABLE PROPERTIES

- Harbor and shores, canals
- Sea and river plots
- Land with groundwater access
- Flood areas
- Areas with groundwater shed
- riverside settlements and sewage treatment plants
- Non-residential buildings such as industrial buildings, commercial and business buildings
- Apartment buildings
- Residential areas (settlements, districts and villages)

CONTENT

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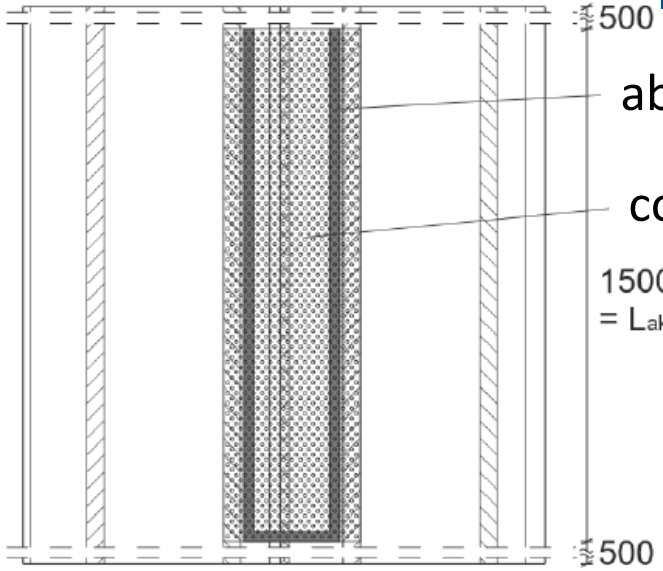
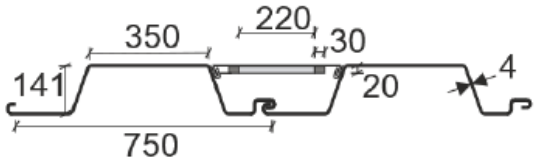
LATEST RESEARCH AT UNIVERSITY OF AACHEN – PERFORMANCE TEST IN FREE WATER



water side



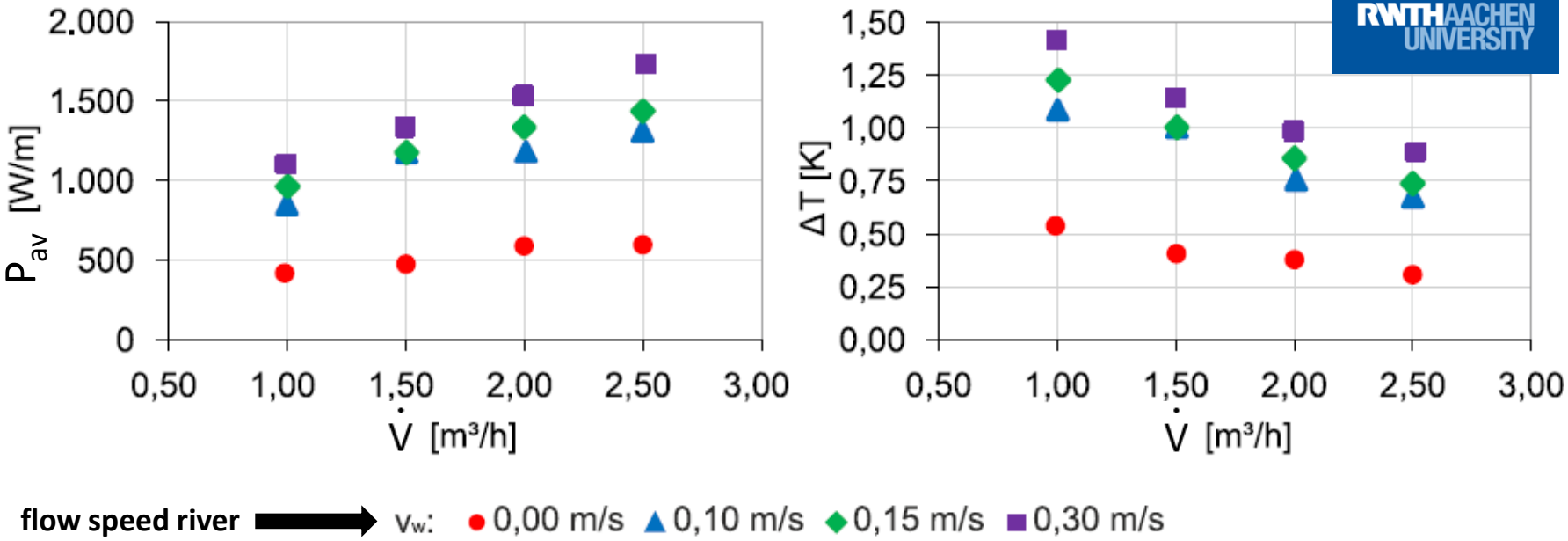
ground side

$$P_{av} = \Delta T \cdot c \cdot \dot{m} / L_{akt}$$

Source: SPS Energy GmbH (Co-Operation partner)

Source: Koppmann et al., Untersuchungen zum Einsatz thermisch aktivierter Spundwände als innovative Möglichkeit zur regenerativen Energiegewinnung, 2019

RESEARCH RESULT: DISRUPTIVE PERFORMANCE OF A WATER APPLIED ENERGY SHEET PILE



- Application: Absorber on the water side of the water
- **Activated absorber length per sheet piling element: 1,50 m**
  - Series connection: 2 x 1.5 m = **3 m in a row**

forward flow temperature: 3 °C

water temperature: 12-13°C

Source: Koppmann et al., Untersuchungen zum Einsatz thermisch aktivierter Spundwände als innovative Möglichkeit zur regenerativen Energiegewinnung, 2019

WHAT DO WE EXPECT – RENEWABLE THERMAL PERFORMANCE

RWTH AACHEN UNIVERSITY

TARGET

as follows

water-side
up to 2 kW/m

ground-side at river
up to 1 kW/m

as follows

ground-side
up to 0,5 kW/m

Source: Koppmann et al., Untersuchungen zum Einsatz thermisch aktivierter Spundwände als innovative Möglichkeit zur regenerativen Energiegewinnung, 2019

- In winter sourced with cold medium from evaporator of heat pump
- In summer free cooling **with an Energy Efficiency Ratio (EER) up to 50 → 20 times higher than state of the art for European Regions!**

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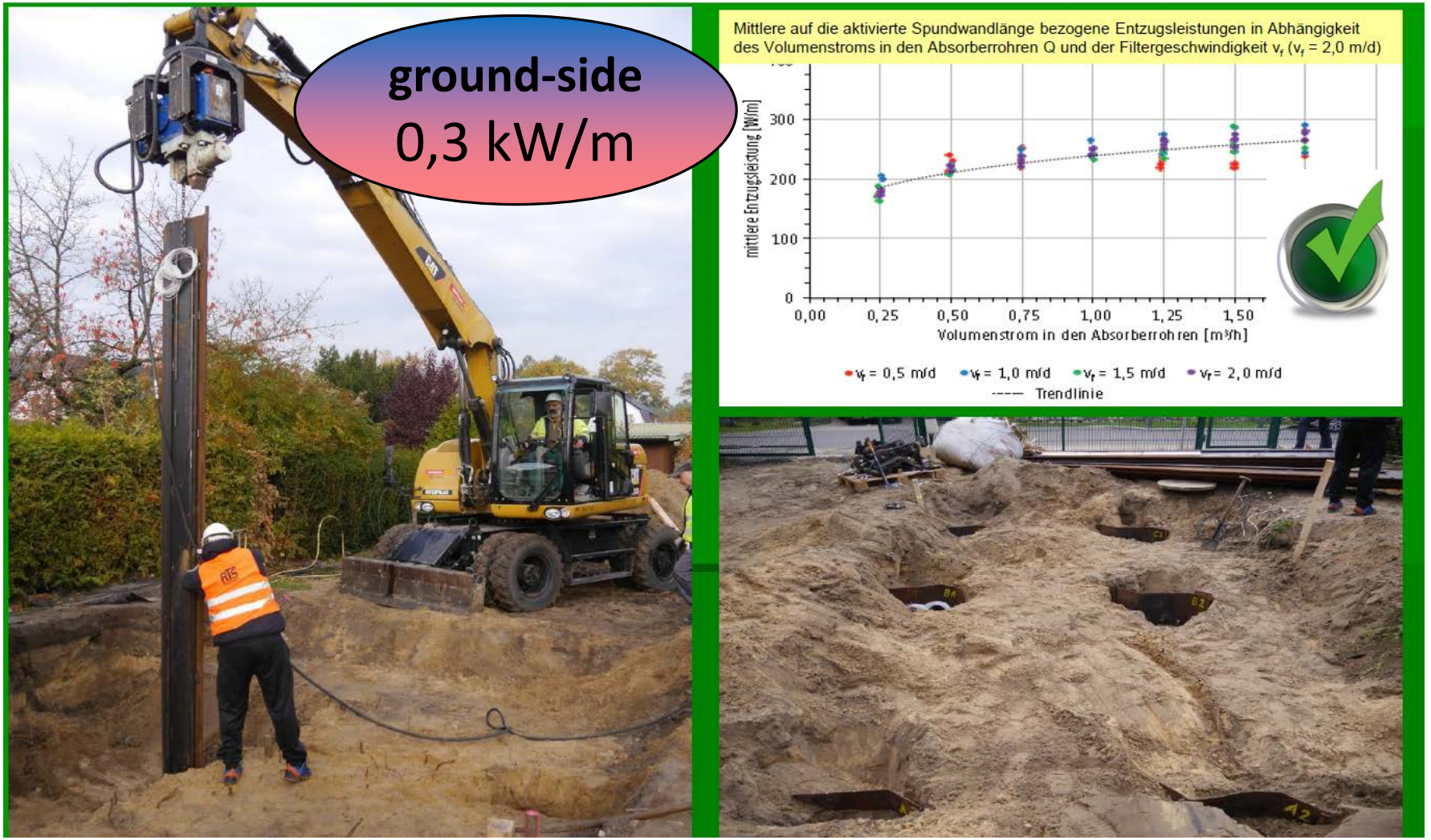
EXAMPLE 1 – VERTICAL GROUND COLLECTOR FOR ONE-FAMILY HOUSE IN BERLIN



Source: SPS Energy GmbH, Germany (Co-Operation partner)

EXAMPLE 2 – HOTEL AT LAKE

ground-side at lake
1 kW/m

application at **land side**

Source: SPS Energy GmbH, Germany (Co-Operation partner)

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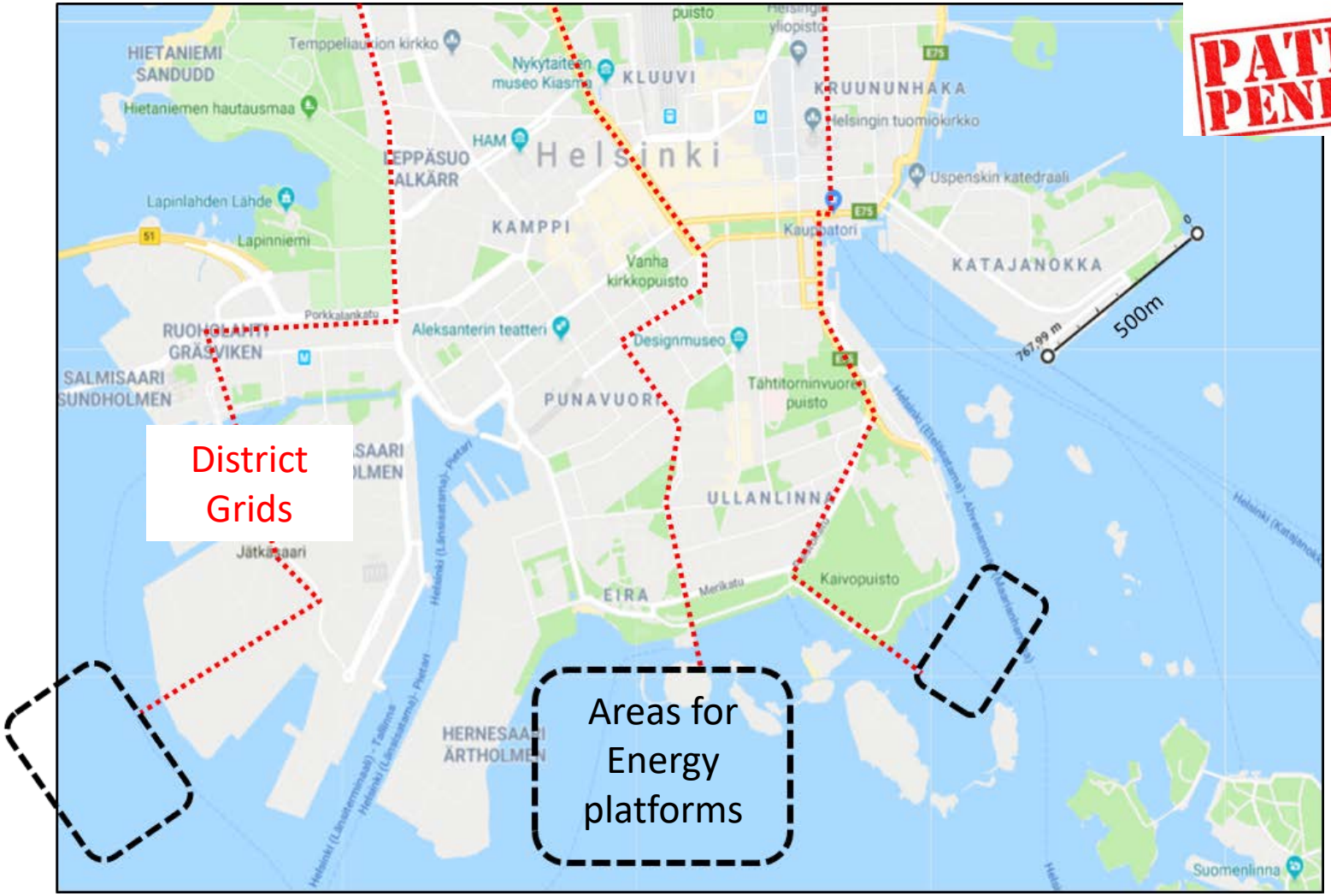
PREPARATION OF THE VISION "ENERGY HARBOR 4.0"



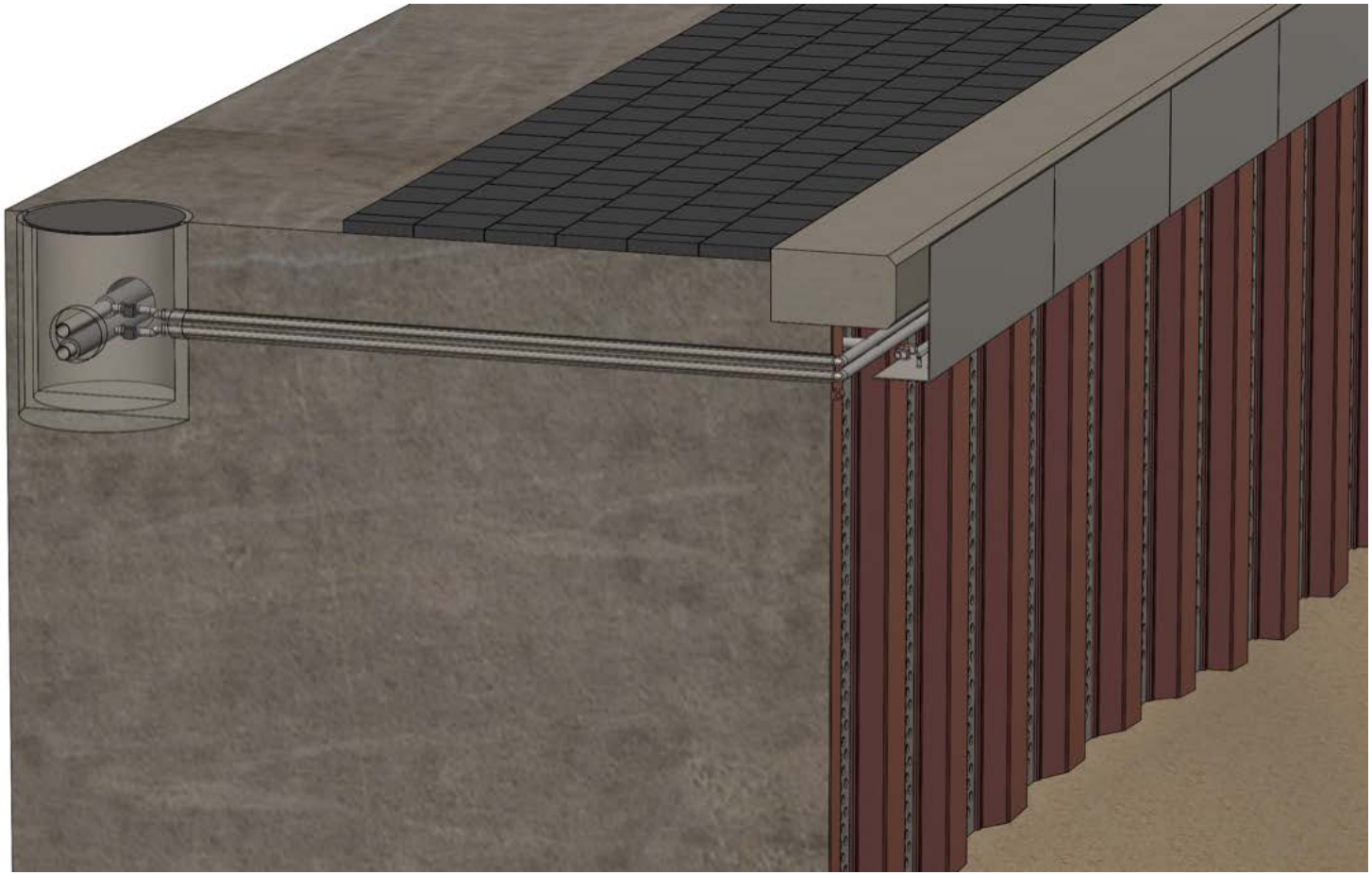
Source: Noll, Heating & Cooling for the Day after Tomorrow, RHC-Conference Helsinki, 2019

CONSTRUCTION PRINCIPLES "ENERGY HARBOR 4.0“ (1/4)

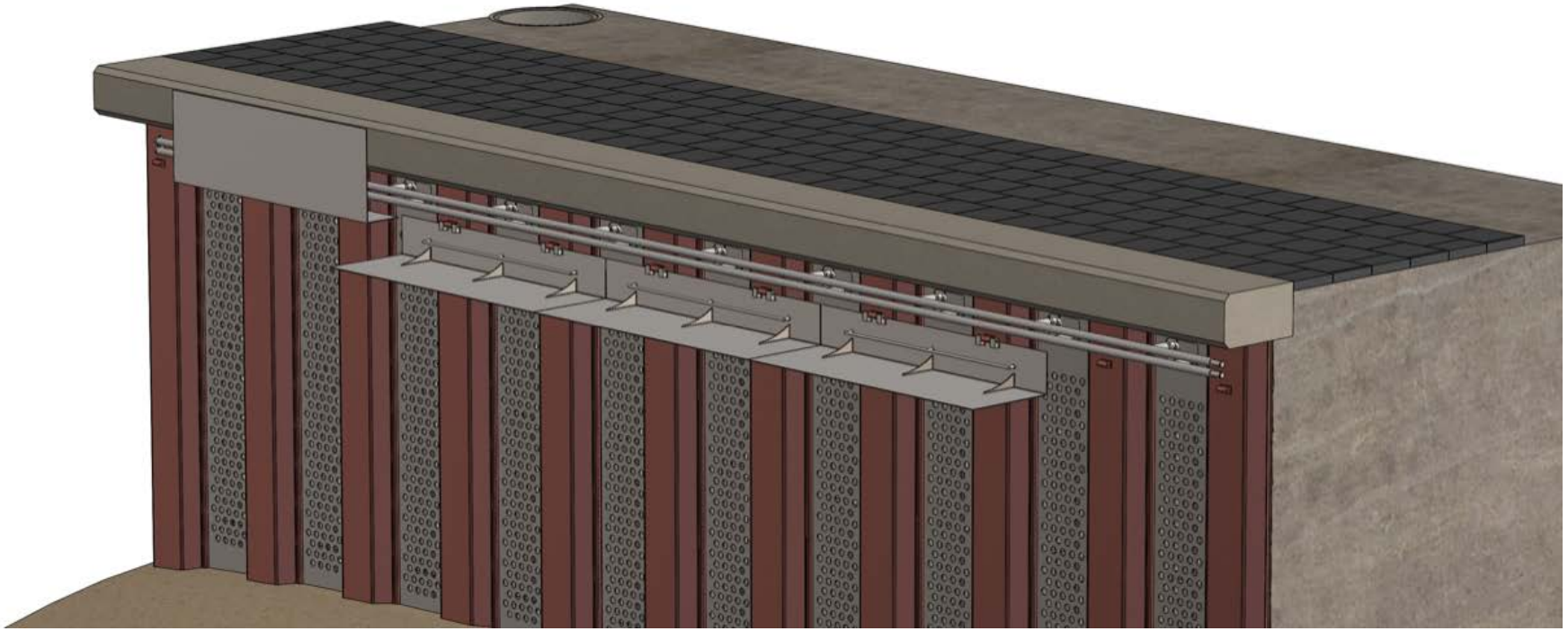
TARGET

water-side
up to 2 kW/m

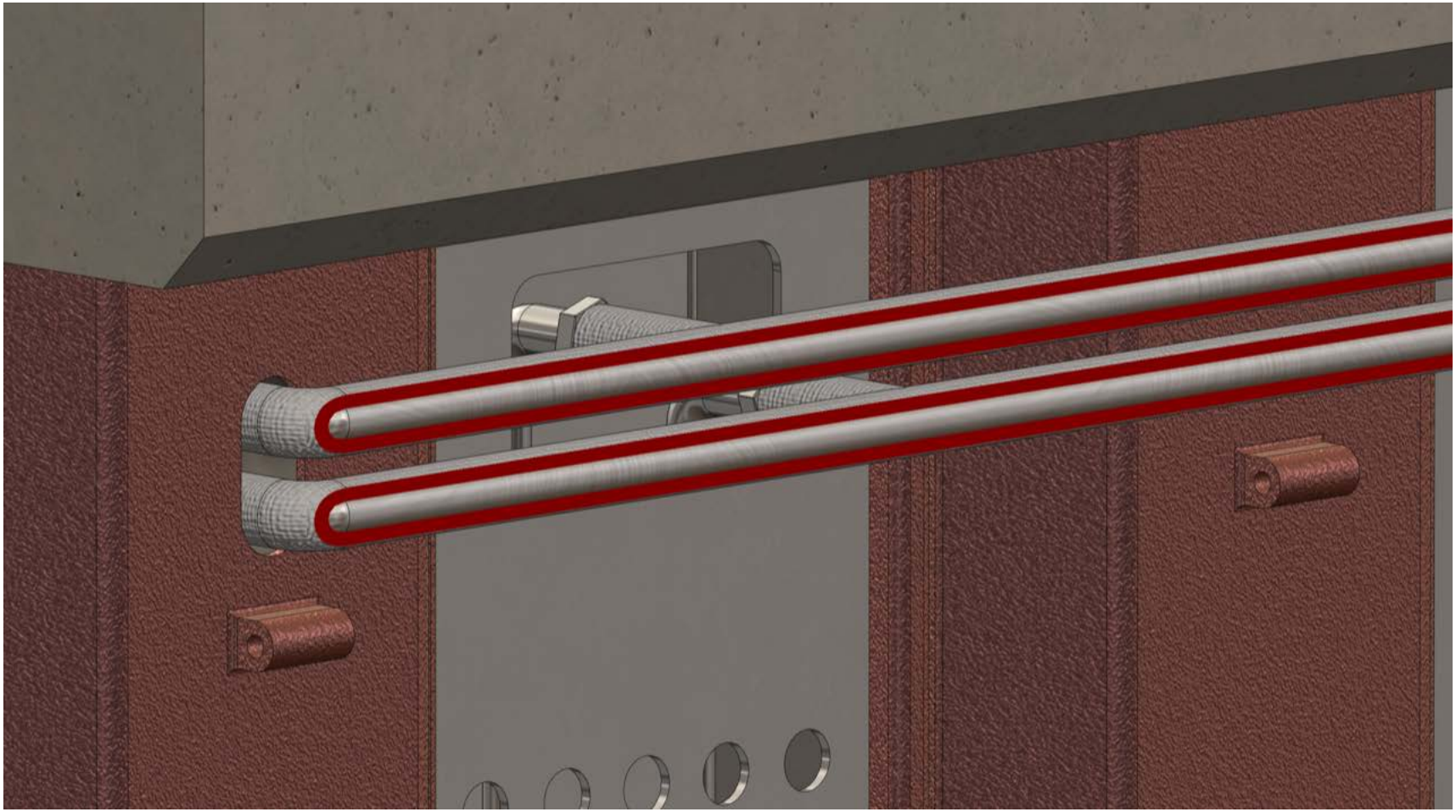
CONSTRUCTION PRINCIPLES "ENERGY HARBOR 4.0“ (2/4)



CONSTRUCTION PRINCIPLES "ENERGY HARBOR 4.0“ (3/4)



CONSTRUCTION PRINCIPLES "ENERGY HARBOR 4.0“ (4/4)



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- **Vision Next – The Hybrid Hydro Power Plant**

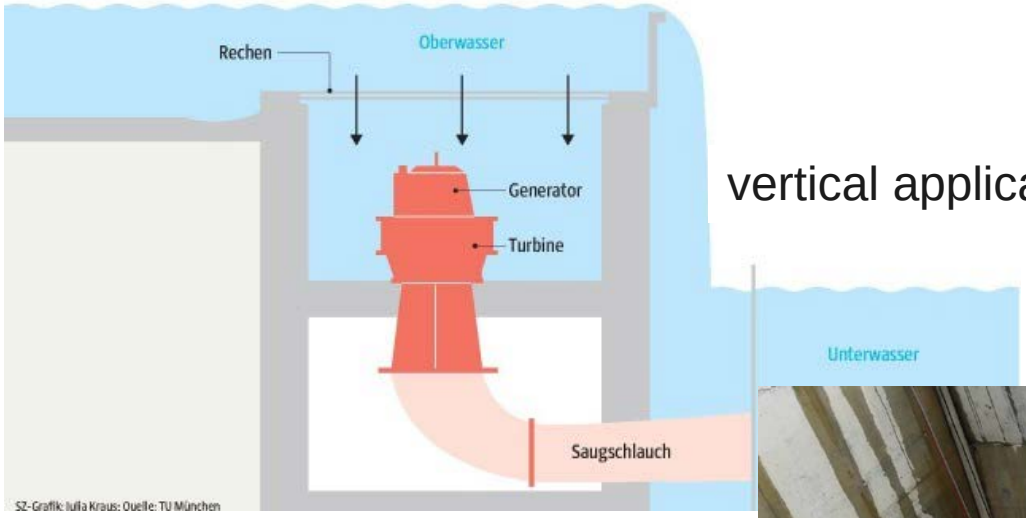
THE VISION BECOMES REALITY!
SUBSYSTEM 1: THERMAL APPLICATION

Source: Puttke, The Hybrid Hydro Power Plant, RHC-Conference Helsinki, 2019

HOW CAN WE GET ELECTRICAL POWER? EXAMPLES BASED ON A SHAFT POWER PLANT

Technical University Munich

longitudinal section of a shaft power plant



Source: Puttke, The Hybrid Hydro Power Plant, RHC-Conference Helsinki, 2019

vertical application

horizontal application

© Kraftwerk Großweil

THE VISION BECOMES REALITY!
SUBSYSTEM 2: ELECTRICAL APPLICATION

Source: Puttke, The Hybrid Hydro Power Plant, RHC-Conference Helsinki, 2019

COMBINING THE SUBSYSTEMS LEADS TO THE HYBRID HYDRO POWER PLANT…

PATENT PENDING

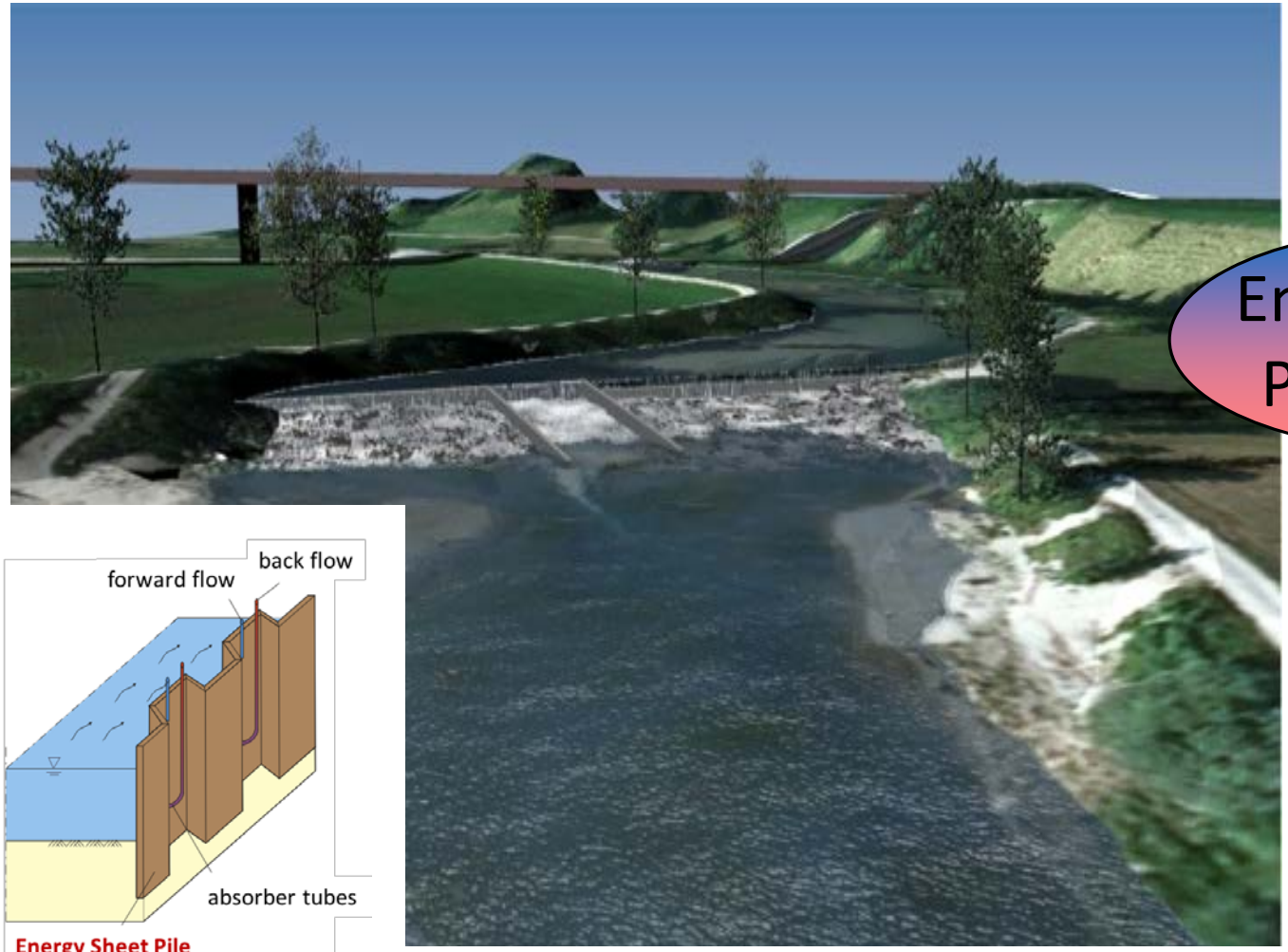
Thermal:
> 5.000 kW
7.000 residents

+

Electrical:
440 kW
2.600 residents

VIRTUAL PREVIEW – THE HYDRO POWER PLANT WITH ENERGY SHEET PILES

Technical University Munich



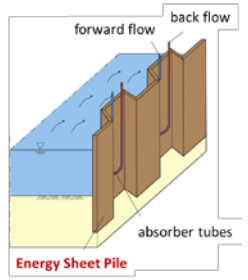
Energy Sheet Piles inside!

Picture: Koppmann, RWTH Aachen, Germany

Source: Puttke, The Hybrid Hydro Power Plant, RHC-Conference Helsinki, 2019

SUMMARY – COMPARISON OF GEOTHERMAL TECHNOLOGIES

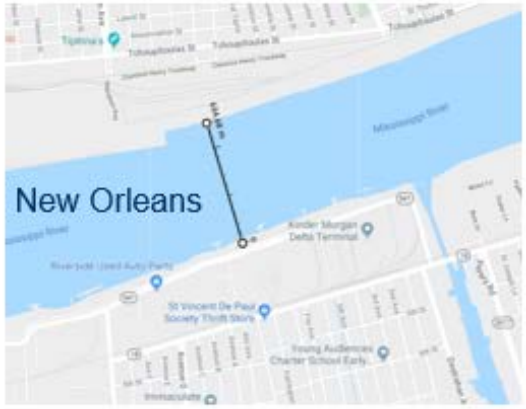
Best practice HP with conventional heat source

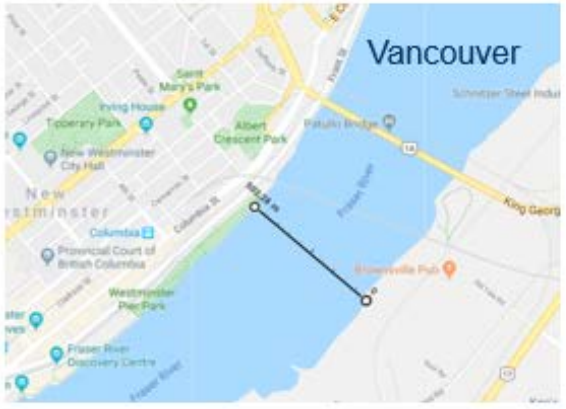


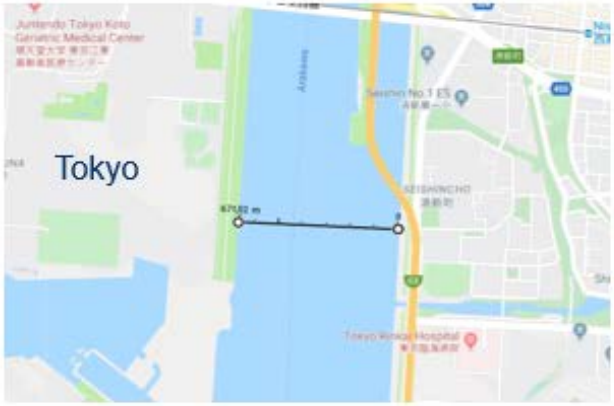
Issue / Heat source	Air (90% MS)	Earth collector	Borehole	Ground water	Energy sheet piles
Availability of source	High	Well	Well	Low	High
Volatility of source	High	Modest	Well	Well	Low (fl. water)
Efficiency of Heat Pump	Low (0,35)	Modest (0,40)	Modest (0,40)	Well (0,45)	High (> 0,45)
Space requirements	Low	High	Well	Well	Low
Complexity of approval	Low	Modest	Modest	High	Low
Complexity of planning	Low	High	High	Modest	Low
Complexity of installation	Low	Modest	Modest	Modest	Low
Cost	Low	Well	Modest	Well	Low
Other	Noise	Recovery of heat source via ST		Add. HEX	Hybrid (+ el. power)

Source: Noll, Heating & Cooling for the Day after Tomorrow, RHC-Conference Helsinki, 2019

THINK ABOUT THE POTENTIAL OF SMART ENERGY CITY CONCEPTS ALL OVER THE WORLD…





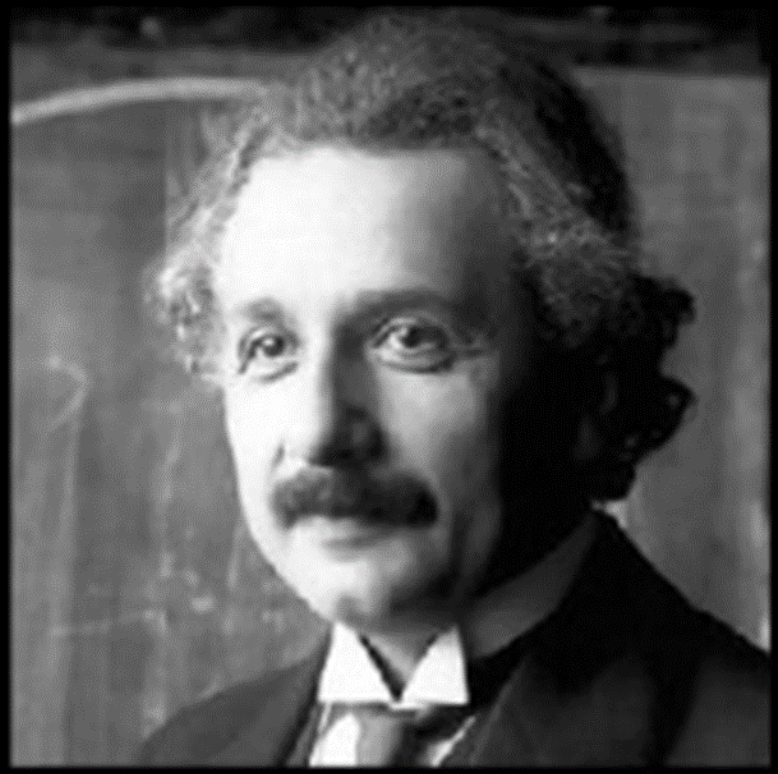


Source: Noll, Heating & Cooling for the Day after Tomorrow, RHC-Conference Helsinki, 2019

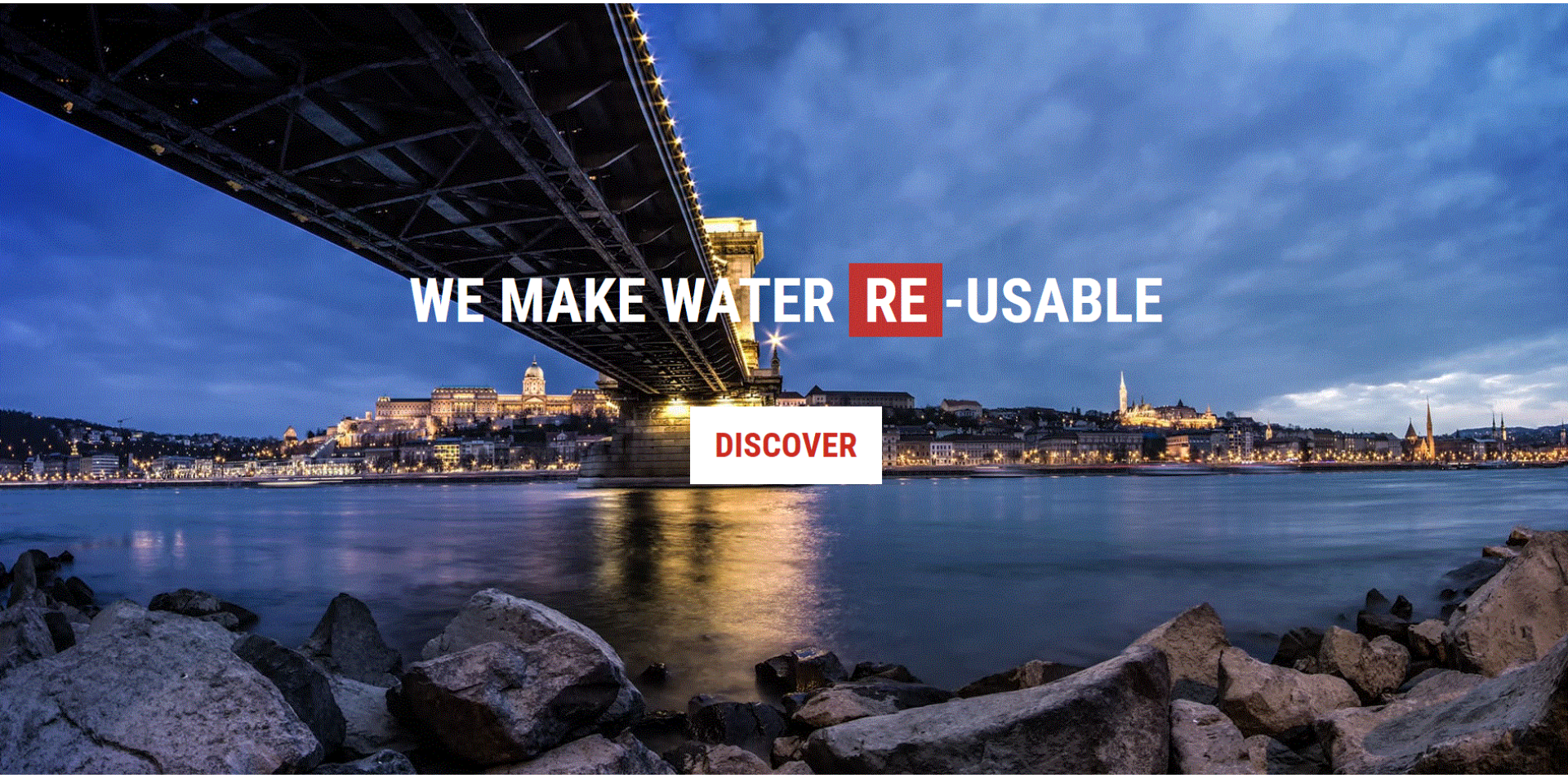
BE INSPIRED!

A really good idea
can be identified
by the fact, that their
realization
has been excluded a
priori.

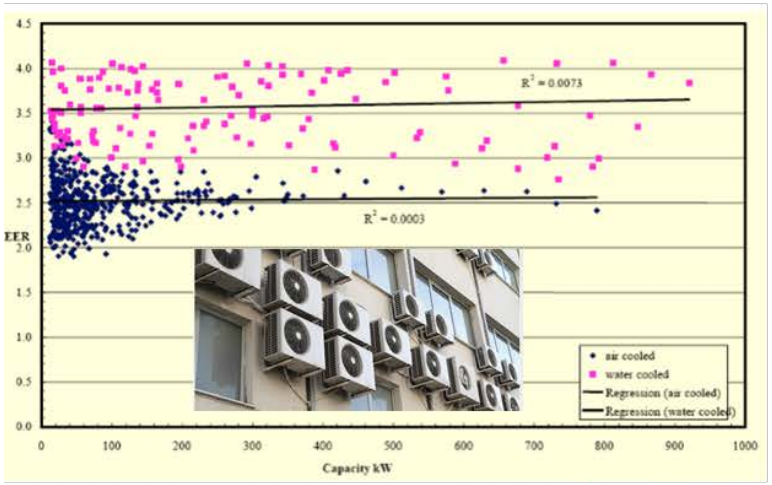
Albert Einstein



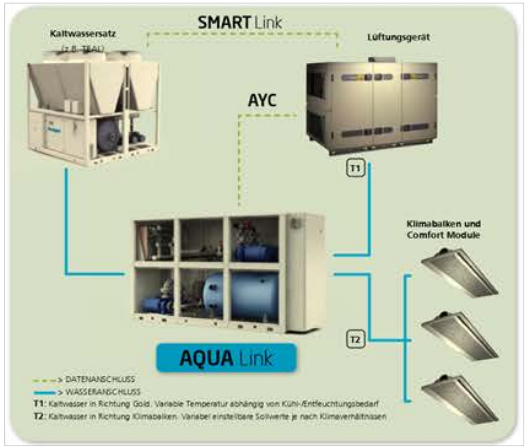
THANK YOU FOR ATTENTION



AN INCREASE IN COOLING EFFICIENCY OF +300% IS POSSIBLE FOR WARMER REGIONS!



Source: [UBA07]



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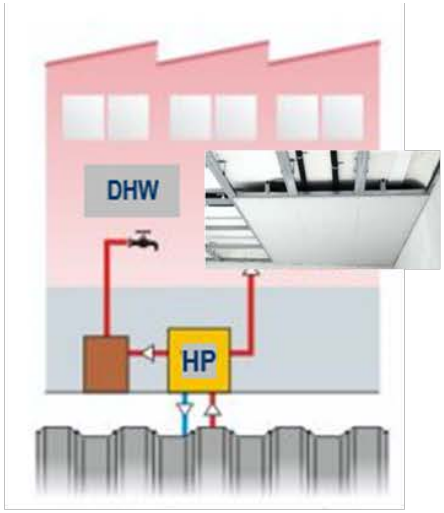

Source: [A2P/res]

	(1) Air cooling	(2) CWA + ceiling	(3) SP + wall cooling
η_{HP}	0,30 (air/air)	0,40 (air/water)	0,5 (water/water)
EER	2,5 @ T_w/T_c=50/12°C	3,0 @ T_w/T_c=50/7°C	10 @ T_w/T_c=30/15°C
Installation effort	low	medium	medium

Source: Noll, Heating & Cooling for the Day after Tomorrow, RHC-Conference Helsinki, 2019